

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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JUN 19 1996

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

In the Matter of)
)
Amendment of Parts 2 and 15 of the) ET Docket No. 96-8
Commission's Rules Regarding Spread) RM-8435, RM-8608, RM-8609
Spectrum Transmitters)

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COMMENTS OF APPLE COMPUTER, INC.

Apple Computer, Inc. ("Apple") hereby submits its comments in response to the Federal Communications Commission's (the "FCC" or "Commission") Notice of Proposed Rule Making ("NPRM") in the above-referenced proceeding, released February 5, 1996. In this proceeding, the FCC proposes to modify the spread spectrum frequency-hopping requirements in the 915 MHz band; to permit higher-gain antennas to be used in the 5800 MHz band under certain conditions; and to clarify, codify and update other portions of the rules in Section 15.247 and the definitions in Sections 2.1 and 15.3.¹ The Commission's recognition of the need to fine-tune the spread spectrum rules is both welcome and timely.

The NPRM addresses three frequency bands that are variously labeled as the "Part 15 spread spectrum" or "ISM" bands. Each band has distinctive attributes that affect how it can be used, reflecting differences in rules, propagation, hardware technologies and antenna characteristics, as well as existing and potential occupancy by other communications services and ISM "noise" producers.

Apple believes that issues concerning operation within the unlicensed bands should be considered in the context of the whole set of such bands. While some of the rules addressed by the NPRM are ripe for change, others implicate broader issues. In particular, one of the bands dealt with by the NPRM, 5725-5850 MHz, also is a subject of the current NII/SUPERNet NPRM.² As a result, some of the issues raised in this proceeding — in particular, issues relating to the use of directional antennas within the 5800 MHz band — cannot be divorced

¹ Apple is utilizing the same nomenclature for these bands as is employed in the NPRM. See NPRM at n.1.

² ET Docket No. 96-102.

from questions being addressed in the NII/SUPERNet proceeding — in particular, issues relating to the use of unlicensed technologies to create new, low cost, flexible “community networks.” Apple urges the Commission to develop positions in this proceeding that take into consideration any comments that may be filed by Apple and others in the NII/SUPERNet proceeding.

I. THE COMMISSION SHOULD MODIFY THE FREQUENCY HOPPING AND CERTAIN OTHER RULES GOVERNING THE 915 MHZ BAND.

From the time the “spread spectrum bands” were first made available for unlicensed communication devices in 1985, the Commission has made it clear that one of the principal goals of the rules governing these bands is to reduce the possibility that unlicensed devices will cause interference to others sharing the bands. To date, the rules have proven effective: for example, tens of millions of unlicensed 915 MHz devices have been shipped while few, if any, legitimate claims of inter-service interference have been made.

The Commission’s recent decision to permit Location and Monitoring Service (“LMS”) systems to operate as primary users of the 915 MHz band, however, has changed the sharing environment for this band in fundamental ways.³ Previously, 26 MHz of spectrum was shared among devices with constrained power and interference-averting modulation schemes. Now, all but 12 MHz of the band can be occupied by multilateration LMS transmitters, and only 10 MHz of the 12 MHz of “reserved” spectrum is contiguous. As the Commission has recognized, sharing between multilateration LMS systems and low-power unlicensed frequency-hopping systems is problematic⁴ and “it would be beneficial if these two operations could avoid sharing the same spectrum.”⁵ As a result, certain changes to the rules governing Part 15 operation in the 915 MHz band should be adopted.

A. The Commission Should Adopt Its Proposed Changes To The Frequency-Hopping Rules For The 915 MHz Band.

The Commission has proposed to reduce from 50 to 25 the minimum number of hopping channels that are required of frequency hopping systems

³ See Report and Order, PR Docket No. 93-61, 10 FCC Rcd 4695 (1995).

⁴ “... [M]ultilateration LMS services are expected to grow at a rapid rate, causing frequency congestion problems for Part 15, LMS and other users of the 915 MHz band.” NPRM at ¶ 31.

⁵ NPRM at ¶ 30.

operating in the 915 MHz band, when certain power and bandwidth limits are met. This change will reconcile and rationalize the band-sharing conditions among LMS and Part 15 devices and should be adopted.

Without this change, initially proposed by SpectraLink and now by the Commission, maximum-bandwidth frequency-hopping devices must transmit in many frequency bands that may already be in use by, or at the least are available for use by, LMS systems. The inevitable result is some number of requisite but predictably unsuccessful transmissions by Part 15 devices — RF signal pollution that has no benefit other than meeting the letter of the (current) rules.

With the proposed change, transmitters occupying bandwidths of 250 kHz or more would be permitted to hop on only 25 channels. As a result, systems with the maximum allowed bandwidth (500 kHz) would be able to avoid most of the frequencies protected for wideband multilateration operations and, with a back-off from 500 to 480 kHz, could utilize only 12 MHz and thereby avoid the multilateration channels altogether. Elimination of *pro forma* channel visits can decrease the channel access “overhead,” most likely more than making up for the slightly reduced bandwidth.⁶

In addition, while the proposed change opens up the potential for more spectrum-efficient systems, it places no additional requirements on devices that comply with the present rules. For each of these reasons, the proposed change should be implemented promptly.

B. The Commission Should Reduce The Power Limit By 3 dB If Fewer Than 50 Channels Are Used.

The Commission’s NPRM suggests a 3 dB reduction, to 0.5 watts, in the maximum allowed power output for devices utilizing fewer than 50 channel hops. Such a change is intended to compensate in part for the possibility of a higher concentration of systems in a reduced portion of the spectrum. The NPRM goes on, however, to request comment on whether a greater reduction in output power is warranted.⁷

⁶ There is no coexistence “etiquette” required of unlicensed device in these bands. Transmit-only devices are not forbidden nor are there limits to the duration that any direct sequence transmitting device — or ISM device — can occupy a channel.

⁷ NPRM at ¶ 33.

It is debatable whether a 3 dB reduction would make any material change in real-life band conditions at any particular locale, even though the 2:1 changes in number of channels and amount of power are numerically rational. It is just as debatable whether a further power reduction would lower interference, or whether its effect would be only to reduce communications performance, including the distance reached. Any greater step-function power reduction at the demarcation between 49 and 50 hops, moreover, would seem only to encourage bandwidth enlargement, thus failing to promote spectrum efficiency and reducing interference only in a limited number of circumstances. As a result, in the interests of offering a nominally balanced intra-service sharing environment, a 3 dB reduction appears reasonable and sufficient, and should be implemented.

C. The Commission Should Adopt Simple, Unambiguous Rules Rather Than Limits Based Upon Complex Formulae.

In comments filed in response to SpectraLink's petition in this proceeding, Itron, Inc. suggested that the Commission adopt a graded power curve based on the number of hopping channels actually used by a spread spectrum transmitter, while Metricom, Inc. argued that the proposed fixed limits on power, coupled with a reduction of the minimum required channel hops, may result in band-crowding outside the frequencies authorized for multilateration systems.⁸ In response to these concerns, the Commission requested comment on whether it should adopt a variety of formulae addressing the minimum number of hopping channels and maximum power levels.⁹

Each of the proposals discussed in the NPRM could have merit for addressing specific channel overload and interference mitigation circumstances. To expect these graded limits to be a cure-all, however, is unrealistic and could result in efforts to utilize the rules in ways that might not promote overall spectrum efficiency. In addition, considering the wide latitude of power, bandwidth and number of hopping frequencies that could result from formula-based rules, such rules would create complexities in conformance that would outweigh their general value.

⁸ See NPRM at ¶ 29.

⁹ NPRM at ¶ 32-33.

In view of the nature of the 915 MHz band as an operational theater for very diverse licensed, unlicensed, and ISM emissions, making channel rules that encourage finely-tuned hardware designs and channel usage schemes to deal with a relatively chaotic interference environment seems, even if useful, to verge on over-kill. A simple expression of limits, as proposed by the Commission, should suffice.

D. The Commission's Rules In Section 15.247 Should Incorporate The Sharing Rules Set Forth In Section 90.361.

The Commission's expressions of the interference relation, status, presumptions and obligations of 915 MHz Part 15 devices with respect to LMS systems, and vice versa, are to date codified only in Section 90.361 of the rules and are not reflected in the proposals of the NPRM. Just as the Commission has found it appropriate to call attention in Section 15.247 to certain rules found elsewhere in Part 15, such as those limiting spurious emissions and external power amplifiers,¹⁰ the additional sharing conditions that are reflected in Section 90.361 should be incorporated by reference or repeated in Section 15.247.

II. THE COMMISSION SHOULD ALLOW INTERFERENCE-AVOIDING ADAPTIVE HOPPING SCHEMES IN ALL THREE OF THE SUBJECT BANDS.

One of the fundamental strengths of frequency hopping technologies is their ability to avoid occupied channels, as long as other spectrum is available. The capability to use intelligent frequency hopping systems, however, previously has not been permitted in the spread spectrum bands because, as the Commission states, it can result in "coordination between hopping transmitters ... [that could] allow ... multiple transmitters to monopolize the spectrum in a given location."¹¹

While each of the bands presents special interference environments and special rules (such as those discussed above with respect to the 915 MHz band) may be warranted to deal with unique circumstances, certain common interference considerations affect operation in each of the spread spectrum bands. For example, the operation of a variety of Part 15 devices, as well as an even more malign (to communications) set of occupants — primarily broadband

¹⁰ See NPRM at ¶¶42, 44.

¹¹ NPRM at ¶ 43.

ISM emitters upon which there are no limits whatsoever on radiated power¹² — may prevent communication on an ever-changing mix of frequencies within each band.

In order to deal with these common problems, systems and individual devices should be allowed to “map” the interference environment and readjust hopping patterns to maximize communications throughput, within the limits on minimum hops and bandwidths in the respective bands.

III. THE COMMISSION SHOULD ENCOURAGE THE USE OF NARROW-BEAM ANTENNAS IN THE 5800 MHZ BAND.

As the Commission is aware, longer-reach unlicensed communications are of primary importance to Apple, the computer and information industries, and a large number of citizens who wish to take full part in the use of the Internet and other elements of the National Information Infrastructure.¹³ For this reason, the Commission’s proposal to eliminate the restriction on directional antennas employed in the 5800 MHz band is of great interest to Apple. This is particularly true because one of the frequency ranges proposed for the NII/SUPERNet Band includes the 5800 MHz “spread spectrum band” addressed in the instant NPRM. Although the instant NPRM would not provide for the entire range of functionalities sought for the NII Band, this proposal represents a first step toward that goal, and any decision reached in this proceeding regarding the circumstances under which directional antennas may (and may not) be used is directly relevant to the Commission’s consideration of community networking in the NII/SUPERNet proceeding.

The general approach proposed by the Commission and petitioners Western Multiplex and Cylink, and the reasons for that approach, closely match some of the goals for the NII Band. That is, unlicensed transmitters employing directional narrow-beam antennas can enable rapid setup, lower costs, greater frequency reuse and a higher information capacity.¹⁴ The Commission has

¹² See Section 18.305 (a) (“ISM equipment operating on a frequency specified in § 18.301 is permitted unlimited radiated power in the band. . .”).

¹³ See “NII Band Petition for Rulemaking” submitted by Apple May 24, 1995, and currently under examination in ET Docket 96-102.

¹⁴ See NPRM at ¶ 6 (citing Western Multiplex petition).

agreed that these functions "could be critical in emergency situations,"¹⁵ and that "the 5800 MHz band is ideal for fixed, point-to-point wideband microwave operations."¹⁶

As Western Multiplex discussed in its petition, a variety of users could benefit from the use of directional, longer-range unlicensed transmitters, including manufacturing and service companies, oil and gas pipeline companies, mobile and SMR operators, common carriers, public safety services, state and local governments and the U.S. Government.¹⁷ This list, while extensive, is still incomplete: Apple would add that the need for longer-reach connections is particularly urgent for a large population of individuals and organizations in rural and other areas unserved by cable or high-grade telephone lines suitable for high-speed modems.

As stated above, Apple will limit its discussion of NII Band issues in this pleading and deal with them in later submissions specifically on the NII/SUPERNet NPRM. However, Apple wishes at this time to reiterate its belief that the use of unlicensed systems employing directional antennas can benefit a wide range of organizations and, through them, individuals. In addition, Apple strongly endorses the general proposal to permit greater use of directional systems in the 5800 MHz unlicensed band.

Apple also urges the Commission to clarify its proposal to permit only non-consumer "commercial and industrial" users to employ directional antenna systems. This restriction is — or could be misconstrued to be — diametric to the interests of the principal beneficiaries of NII Band communications. Municipalities, health care and educational institutions, and other similar entities and coalitions must be permitted to use longer-reach systems in the 5800 MHz band, and Apple urges the Commission to adopt language in its Order that explicitly confirms that intent.¹⁸

¹⁵ NPRM at ¶ 9.

¹⁶ NPRM at ¶ 11.

¹⁷ See NPRM at ¶ 6.

¹⁸ It may be appropriate to separate the responsibilities for engineering and installation of point-to-point systems from the right to operate such systems.

IV. THE COMMISSION SHOULD RELAX THE RESTRICTIONS ON DIRECTIONAL ANTENNAS EMPLOYED IN THE 2450 MHZ BAND.

Although the Commission has indicated that it is not inclined to relax restrictions on directional antennas in the 2450 MHz band, it would appear that the dominant source of RF energy in that band is not unlicensed Part 15 devices, but wideband ISM RF noise sources. In such cases, unlicensed communicators have a number of strikes against them in dealing with the high noise floor that commonly prevails. Any redress of the disadvantages of communicating in that band should be encouraged, and will not affect ISM occupants. In view of the high noise floor, directionality would be a useful tool to have available in the 2450 MHz band even for indoor applications such as wireless LANs and PBXs, as well as "LAN bridges" and other inter-building links.

V. THE COMMISSION SHOULD REQUIRE COMPLIANCE BY ALL UNLICENSED DEVICES WITH THE PERTINENT SECTIONS OF IEEE C95.1-1991.

The Commission, in Subpart D of Part 15, requires manufacturers of unlicensed PCS devices to affirm that those devices comply with IEEE C95.1-1991, to assure that the public is not unknowingly exposed to excessive radio frequency signal levels.¹⁹

The Commission has solicited comment on possible biological hazards of radiators in the 5800 MHz "spread spectrum band" and on means to limit exposure to them. The Commission's inquiry is positioned around discussions of directional antennas and uncontrolled environments.²⁰

In point of fact, the IEEE standard entails measurement of "radiated power," as appropriately mentioned in Section 15.319(i). "Radiated power" is defined as power measured at the input to the antenna. There is no dependency upon EIRP.

¹⁹ See Section 15.319(i). Apple called for similar compliance to prevailing standards, of all Data-PCS and voice-PCS devices, in its original Data-PCS petition. "Data-PCS - Petition for Rulemaking," RM 7618, at 28-29 (submitted January 28, 1991).

²⁰ See IEEE C95.1-1991 at pp. 9 and 12 for definitions of controlled and uncontrolled exposure environments. The IEEE standard provides an exemption from SAR testing of devices having a power of ≤ 100 mW of "radiated power," not EIRP.

The difference between "radiated power" and EIRP is at the heart of many of the discussions in both the instant NPRM and in the NII/SUPERNet NPRM. The term "high power" has been loosely applied, in some instances perjoratively or inaccurately or both.

The gain of an antenna in a particular direction does not increase the "power" of the transmitter output. A high-gain antenna of less than Herculean proportions does not produce the pinpoint or pencil-eraser sized spot of energy concentration produced by a (coherent) laser-beam pointer. In fact, at any distance at all it does not limit the narrow beam to a barn door dimension, and when employed for point-to-point links, the beam of coverage will have a cone shape with an angular component of several degrees. The amount of energy produced by the transmitter is not increased by a single nanowatt. Thus, a directional antenna can cause interference, or possible RF exposure, at a longer distance in one direction than an isotropic or omnidirectional antenna, but with no greater amount of energy than is encountered closer to transmitters feeding low-gain antennas.

Accordingly, the emphasis of the Commission should not be solely on directional antennas, but on all antennas and transmitters, with due consideration and allowance for the life cycles of existing products and those now being designed. Meanwhile, some one or several of the measures described in the NPRM,²¹ and others that may be suggested by interested parties in this proceeding, should be required by the Commission.

VI. MOST OF THE COMMISSION'S "ADDITIONAL PROPOSALS" SHOULD BE ADOPTED AS PROPOSED IN THE NPRM.

The Commission has listed a number of "additional proposals" that would clarify the Commission's regulations, more appropriately define certain terms, and tighten certain loose ends that have appeared in the eleven years since the "spread spectrum rules" first were released.

In addition to points already discussed above, Apple concurs with the Commission's proposals to:

²¹ NPRM at ¶ 14.

1. Change to a peak measurement of output power of direct sequence transmitters;
2. Refine and update definitions of direct sequence spread spectrum and of "pseudorandom" hopping patterns;
3. Maintain its position that short-burst transmissions must actually hop to different frequencies in order to qualify under the rules;
4. Allow indirect measurement of processing gain by determining "jamming margin";
5. Simplify, clarify, and collect within Section 15.247 the rules on unwanted emissions; and
6. Explicitly preclude use of unauthorized external power amplifiers.²²

CONCLUSION

Apple supports the objectives of the "spread spectrum NPRM" and urges prompt implementation of the Commission's proposals except as noted herein, in order to provide even greater utility for these already-popular unlicensed bands.

Respectfully submitted,

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June 19, 1996

²² Apple will address antenna provisions in its comments on the NII/SUPERNET NPRM.